SECTION III
OPERATION

3-1. INTRODUCTION

3-2. This section provides all the information necessary to operate the Model 4280A 1MHz C METER/C-V PLOTTER. Included are descriptions of the front and rear-panel controls, displays, lamps and connectors; discussions on operating procedures and measurement techniques for various applications; and instructions on the instrument's SELF TEST function. Warnings, Cautions, and Notes are given throughout; they should be observed to insure the safety of the operator and the serviceability of the instrument.

WARNING

BEFORE THE INSTRUMENT IS SWITCHED ON, ALL PROTECTIVE EARTH TERMINALS, EXTENSION CORDS, AUTO-TRANSFORMERS AND DEVICES CONNECTED TO IT SHOULD BE CONNECTED TO A PROTECTIVE EARTH GROUNDED SOCKET. ANY INTERRUPTION OF THE PROTECTIVE EARTH GROUNDING WILL CAUSE A POTENTIAL SHOCK HAZARD THAT COULD RESULT IN SERIOUS PERSONAL INJURY.

ONLY FUSES OF THE CORRECT CURRENT RATING AND OF THE SPECIFIED TYPE SHOULD BE USED. DO NOT USE REPAIRED FUSES OR SHORTED FUSE-HOLDERS. TO DO SO COULD CAUSE A SHOCK OR FIRE HAZARD.

CAUTION

BEFORE THE INSTRUMENT IS SWITCHED ON, IT MUST BE SET TO THE VOLTAGE OF THE POWER SOURCE (MAINS), OR DAMAGE TO THE INSTRUMENT MAY RESULT.

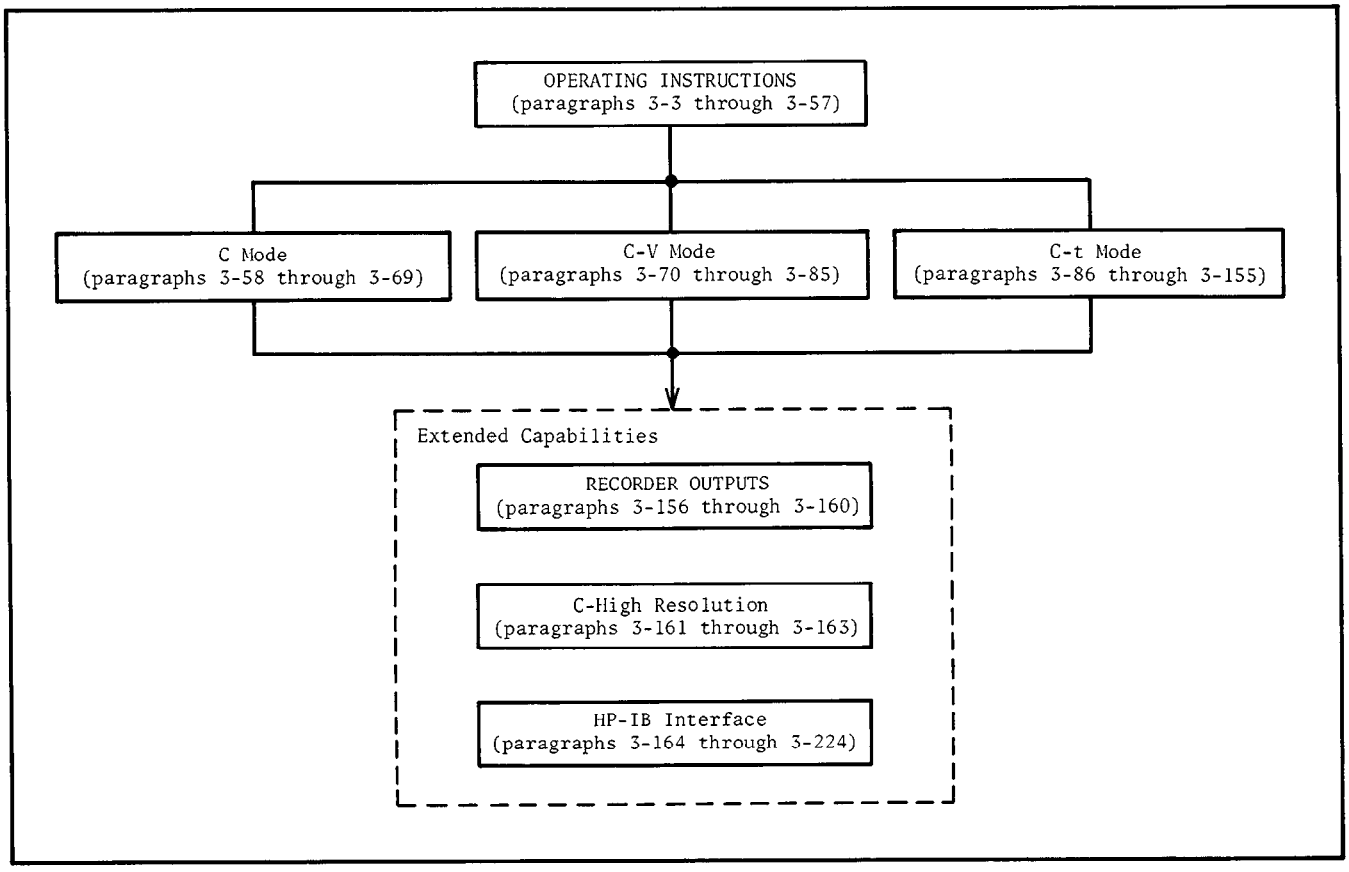


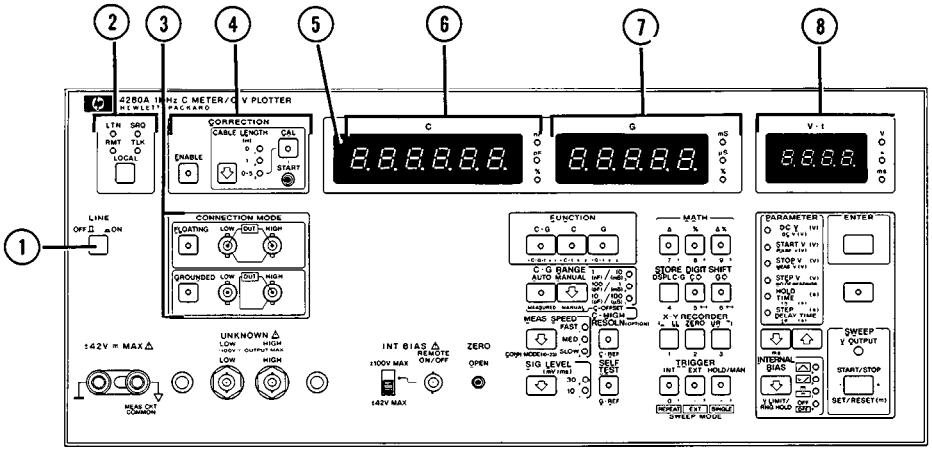
Figure 3-1. Contents of Section III

3-3. OPERATING INSTRUCTIONS

3-4. Operating instructions for the instrument's basic capabilities are given in paragraphs 3-3 through 3-57. Operating instructions for Extended Capabilities (X-Y Recorder Outputs, C-High Resolution measurement, remote operation via the HP-IB) are covered in paragraphs 3-156 through 3-224.

3-5. PANEL FEATURES

3-6. Figures 3-2 and 3-3 identify and briefly describe the purpose of each key, indicator, and connector on the front and rear panels, respectively. Detailed information on front panel displays and controls is given starting in paragraph 3-7.



(1) LINE OFF/ON:

Applies ac line power to the instrument when set to the ON (▬) position. Removes ac line power when set to the OFF (■) position.

(2) HP-IB Status Indicators and LOCAL Key:

These four LED lamps—LTN, SRQ, TLK and RMT (listen, service request, talk and remote, respectively)—indicate the status of the 4280A when it is interfaced with a computer or a listen-only device (printer, for example) via the HP-IB. The LOCAL key, when pressed, releases the instrument from remote (RMT) HP-IB control, enabling front panel control. The LOCAL key is disabled (does not function) when the instrument is set to "local lockout" by the controller.

(3) CONNECTION MODE:

These keys change the 4280A's internal circuitry to allow floating or grounded measurements. FLOATING and GROUNDED are the 4280A's basic connection modes. Many more connection modes are also possible. Refer to CONN MODE (34) and paragraph 3-31.

FLOATING:

Pressing this key automatically configures the UNKNOWN terminals (27) for a floating measurement. Connect the DUT as shown in the drawing adjacent to the key.

When this key is pressed, the key indicator lamp comes on and C n 10 (CONNECTION MODE 10) appears on the V•t display (8). (This connection mode can be selected with the CONN MODE (34) key also. The FLOATING key indicator lamp comes on and connection mode code appears on the V•t display.)

GROUNDED:

Similar to the FLOATING key except that the UNKNOWN terminals (27) are configured for a grounded measurement, CONNECTION MODE 15, and C n 15 is displayed on the V•t display. Connect the DUT as shown in the drawing adjacent to the key.

Figure 3-2. Front Panel Features (Sheet 1 of 12)

④ CORRECTION:

This key group provides internal correction of measurement errors caused by the parasitic elements of the measurement circuit, test fixture, and test leads.

ENABLE:
Enables internal correction calculations using stored constants and ZERO OPEN (25) data. When the correction mode is released (ENABLE key indicator lamp off), internal correction calculations are not performed, thus reducing measurement time.

CABLE LENGTH:
Selects the nominal cable length for use in the internal correction routines. The selected cable length should agree with the test fixture or test leads connected to the UNKNOWN terminals (27). The lighted indicator lamp shows the selected cable length.

0(m): Select this setting when using a direct attachment type test fixture (for example, the furnished 16080A Test Fixture).

1(m): Select this setting when using the 16082A one meter test leads.

0-5(m): Select this setting when using test leads that are shorter or longer (up to 5m) than one meter (for example, the 16081A two meter test leads or test leads made from PN: 8120-4195 coaxial cable). CABLE LENGTH calibration must be performed.

CAL and START:
This key and button function only when the 0-5(m) cable length setting is selected. Pressing CAL lights the key indicator lamp and enables CABLE LENGTH calibration. Pressing the START button initiates the calibration sequence. During calibration, the 4280A measures the capacitance of the cable connected to the UNKNOWN HIGH terminal (27) and stores the results (displayed on the C and G displays) that will be used in the correction calculations. The cable must be open terminated during calibration. At the completion of the calibration sequence, the CAL key indicator lamp will go off automatically. After performing ZERO OPEN (25) the ENABLE key will function normally.

⑤ Trigger Lamp:

This lamp comes on each time the instrument is internally, externally, or manually triggered. Trigger mode is set by the TRIGGER keys (18). When INT TRIGGER mode is selected, the trigger lamp flashes at the internal measurement rate.

⑥ C Display and Unit Indicators:

Displays measured values of capacitance, the instrument's HP-IB address (at turn on), calculation results (see MATH (14)), calculation reference values (see STORE DISPL (16) and C-REF (33)), C-OFFSET values (option 001 only, see C-HIGH RESOLN (21) AND C-OFFSET (33)), and various messages and error codes (SELF TEST). Maximum number of display digits and maximum display count depend on the type of measurement being made, option installation, and certain control settings. The C display is turned off (blank) for G, G-V, and G-t measurements. Unit indicators (nF, pF, %) show the appropriate unit for the displayed value.

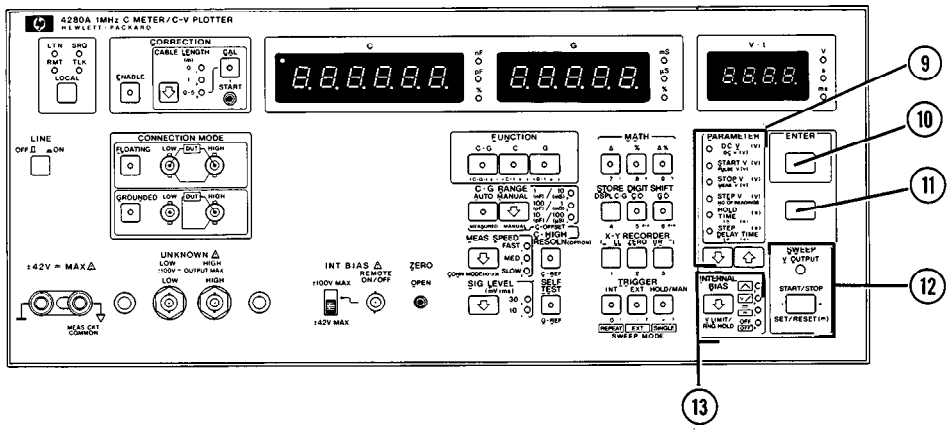
⑦ G Display and Unit Indicators:

Displays measured values of conductance, calculation results (see MATH (14)), calculation reference values (see STORE DISPL (16) and G-REF (33)), and messages related to the X-Y RECORDER function (17). Maximum number of display digits and maximum display count depend on the type of measurement being made, and certain control settings. The G display is turned off (blank) for C, C-V, and C-t measurements. Unit indicators (mS, µS, %) show the appropriate unit for the displayed value.

⑧ V·t Display and Unit Indicators:

Displays bias voltage settings, time settings, connection modes, error codes related to illegal operation, and messages for special measurements (for example, CbL for CABLE LENGTH CAL, O-oP for ZERO OPEN). Unit indicators (V, s, ms) show the appropriate unit for the displayed value.

Figure 3-2. Front Panel Features (Sheet 2 of 12)



(9) PARAMETER Select Keys and Indicators:

These keys select voltage and time parameters for entry. The entered value of the selected parameter (indicator lamp on) is displayed on the V·t display (8). To enter a parameter value, repeatedly press the ⇩ or ⇧ key until the indicator lamp adjacent to the desired parameter is lit. Then press the Blue key (11) (key indicator lamp will come on) and key in the desired value with the Numeric keys (31). Finally, press the ENTER key (10). Parameter selection depends on the connection mode (see CONN MODE (34)) and internal bias mode (see INTERNAL BIAS (13)). A brief description of each parameter is given below.

DC V (V):
Voltage output from the internal dc bias source--used in C mode.

START V (V):
Start Voltage for bias sweeps made with the internal dc bias source--used in C-V mode.

STOP V (V):
Stop voltage for bias sweeps made with the internal dc bias source--used in C-V mode.

STEP V (V):
Step voltage for bias sweeps made with the internal dc bias source--used in C-V mode.

HOLD TIME (s):
Hold time for the START and STOP voltages of a bias sweep made with the internal dc bias source--used in C-V mode

STEP DELAY TIME (s):
Delay time for each STEP voltage of a bias sweep made with the internal dc bias source--used in C-V mode.

The following six parameters are labelled in gray on the front panel and are selectable only when the instrument is in C-t mode (see FUNCTION (19)).

DC V (V):
Voltage output from the internal dc bias source.

PULSE V (V):
Pulsed bias voltage output from the internal dc bias source.

MEAS V (V):
Voltage output from the internal dc bias source after the bias pulse (PULSE V) is removed.

NO OF READINGS:
Number of measurements.

th (s):
Duration of bias pulse (internally and externally supplied).

td (s):
Time between measurements.

(10) ENTER Key:

This key must be pressed after a parameter value, reference value, or connection mode number has been keyed in with the Numeric keys (31).

Figure 3-2. Front Panel Features (Sheet 3 of 12)

(11) Blue Key:

This key must be pressed to access functions labelled in blue. Once pressed, the blue key remains on (key indicator lamp is lit) until a blue function key and the ENTER key (10) have been pressed, or until the blue key is pressed again.

(12) SWEEP/V OUTPUT (Indicator and Key):

The V OUTPUT (red indicator) lamp comes on when the 4280A is performing a biased (internal dc bias source) non-sweep measurement in C mode or a swept (bias or time) measurement in C-V or C-t mode. The SWEEP/V OUTPUT (gold-colored) key (START/STOP-SET/RESET) starts and stops swept measurements in C-V and C-t modes, and sets (turns on) and resets (turns off) the internal dc bias source in C mode. Under certain combinations of measurement mode and connection mode, if INTERNAL BIAS is set to OFF, this key does not function. Operation of this key depends also on the sweep mode (see TRIGGER/SWEEP MODE (18)).

Note

The V OUTPUT lamp blinks on and off when the current through the DUT exceeds the output capability of the internal dc bias source.

WARNING

IF V OUTPUT LAMP BLINKS ON AND OFF WHEN NOTHING IS CONNECTED TO THE UNKNOWN TERMINALS, THE 4280A IS MALFUNCTIONING AND DANGEROUS VOLTAGE MAY BE PRESENT AT THE UNKNOWN TERMINALS.

(13) INTERNAL BIAS Key and Indicators:

This key selects the function of the internal dc bias source and, in some respects, determines the measurement mode. Selectable functions depend on connection mode. Each function is briefly described below.

(Double Staircase Bias Sweep):
Sets the 4280A to C-V mode. The internal dc bias source will sweep its output in an up-down staircase fashion in accordance with the previously entered sweep parameters.

(Single Staircase Bias Sweep):
Sets the 4280A to C-V mode. The internal dc bias source will sweep its output in a single staircase fashion in accordance with the previously entered sweep parameters.

⎓ (DC Bias):
Sets the 4280A to C mode (non sweep). The internal dc bias source will output the previously entered bias voltage.

OFF:
Sets the 4280A to C mode (non sweep). Turns off the internal dc bias source.

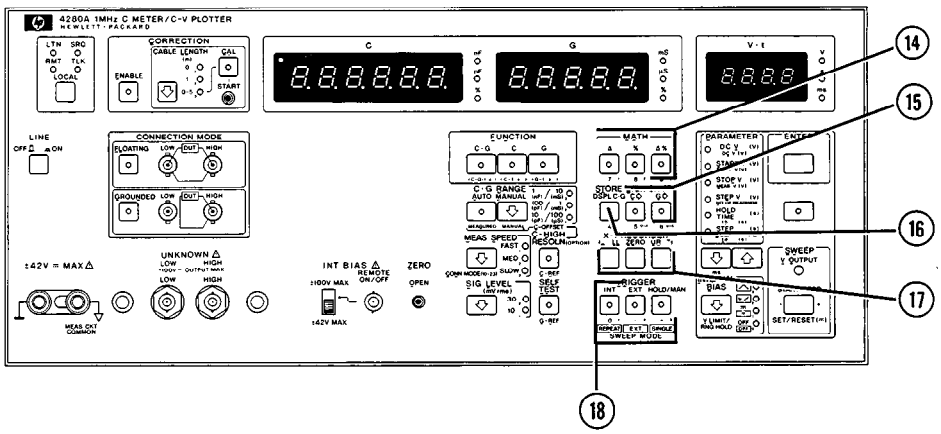
The following three functions are labelled in gray on the front panel and are selectable only when the instrument is in C-t mode (see FUNCTION (19)).

(Pulsed Bias):
The internal dc bias source outputs a pulse whose height and width are determined by the previously entered PULSE V and th parameters, respectively, and then outputs the specified MEAS V voltage for the remainder of the measurement sequence.

⎓ (DC Bias):
This function is used for connection modes requiring pulsed biasing from an external voltage source. The internal dc bias source outputs the previously entered bias voltage after the bias pulse period (determined by th).

OFF:
Turns off the internal dc bias source.

Figure 3-2. Front Panel Features (Sheet 4 of 12)



(14) MATH Keys:

These keys instruct the 4280A to calculate difference (Δ), percent (%), and percent difference (Δ %). Once pressed, the key remains on (key indicater lamp on) until it is pressed again or until another MATH key is pressed. When one of these keys is pressed, values displayed on the C display (6) and G display (7) are calculation results, not measured values.

Δ (difference):

Calculates the difference between the measured value of the device under test and a previously stored reference value. The formula used is

$$A - B$$

where A is the measured value of the device under test and B is the stored reference value.

% (percent):

Computes the percentage relationship between the measured value of the device under test and a previously stored reference value. The formula used is

$$\frac{A}{B} \times 100 \ (\%)$$

where A and B are as described above in the explanation of the Δ key.

Δ % (percent difference):

Computes the percent difference between the measured value of the device under test and a previously stored reference value. The formula used is

$$\frac{A-B}{B} \times 100 \ (\%)$$

where A and B are as described in the exlanation of the Δ key.

(15) DIGIT SHIFT Keys:

These keys are related to the 4280A's X-Y RECORDER function. They reduce the number of digits displayed on the C display (6) and G display (7) to prevent the G and C-G recorder outputs ((11) in Figure 3-3) from saturating. Refer to paragraph 3-156 for details.

C ⇨ :

Each time this key is pressed, the least significant digit (right-most digit) of the number appearing on the C display (6) is deleted. The new number is automatically rounded and shifted one display position to the right. Only digits to the right of the decimal point can be deleted. The complete number can be redisplayed by repeatedly pressing this key until the key indicator lamp goes off. This key does not function when the C display is turned off (FUNCTION (19) is set to G).

G ⇨ :

Functions identically to the C ⇨ key (described above) for numbers appearing on the G display (7). This key does not function when the G display is turned off (FUNCTION (19) is set to C).

Figure 3-2. Front Panel Features (Sheet 5 of 12)

(16) STORE DISPL C·G Key:

Pressing this key stores the values displayed on the C display (6) and G display (7). The stored values are used as reference values in calculations made by the 4280A's MATH functions (MATH (14)). Previously stored reference values are erased and replaced with displayed values each time this key is pressed. If the C or G display is turned off (FUNCTION (19) is set to C or G) when this key is pressed, the previously stored reference value of the turned-off display is not updated.

(17) X-Y RECORDER Keys:

These keys are used when setting the lower left, upper right, and absolute zero scaling points on an X-Y recorder connected to the recorder outputs (RECORDER OUTPUTS (11) in Figure 3-3) on the rear panel. They function when TRIGGER (18) is set to HOLD/MAN or when the 4280A is in, C-V or C-t mode and is not measuring.

↓← LL(lower left):
When this key is pressed, -10V is output from each recorder output connector on the rear panel. The lower left scaling point (X and Y minimum) on the X-Y recorder can be set.

ZERO (absolute zero):
When this key is pressed, 0V is output from each recorder output connector on the rear panel. The absolute mid-point of the plot area on the X-Y recorder can be set.

UR→↑(upper right):
When this key is pressed, +10V is output from each recorder output connector on the rear panel. The upper right scaling point (X and Y maximum) on the X-Y recorder can be set.

(18) TRIGGER/SWEEP MODE Select Keys:

These keys select the trigger mode for non-sweep measurements (C mode) and the sweep mode for swept measurements (C-V and C-t modes).

INT:
This key selects internal triggering. Measurement is made at a rate equal to that of the internal trigger signal.

EXT:
This key selects external triggering. An external trigger device or a TTL level trigger signal must be connected to the EXT TRIGGER connector ((3) in Figure 3-3) on the rear panel. Measurement is made each time a positive-going TTL level pulse is applied to the center conductor of the connector.

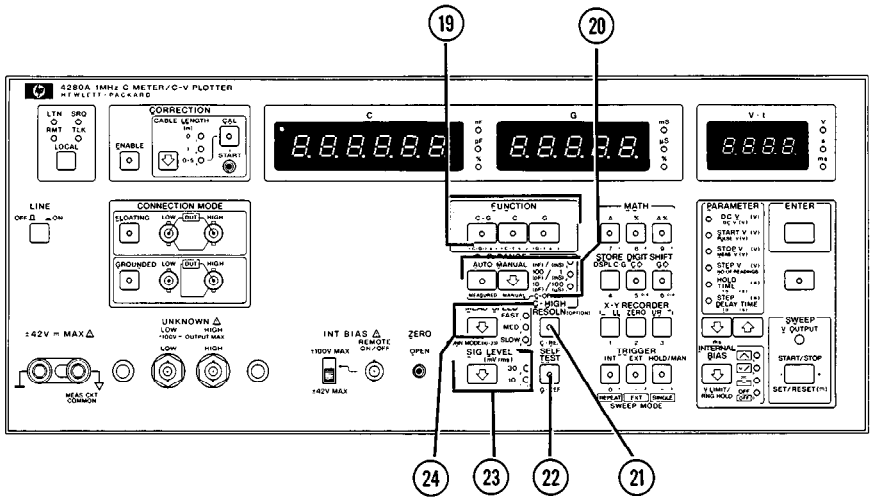
HOLD/MAN:
This key is for manual triggering. Measurement is made each time this key is pressed. Measurement data is held until the key is pressed again.

REPEAT:
When this mode is selected in C-V or C-t mode, (swept) measurements are started by pressing the SWEEP/V OUTPUT key (12), and are repeated until the SWEEP/V OUTPUT key is pressed again.

EXT:
When this mode is selected in C-V or C-t mode, single sweep measurement is started by an external trigger signal applied to the EXT TRIGGER connector (3) in Figure 3-3) on the rear panel.

SINGLE:
When this mode is selected in C-V or C-t mode, single sweep measurement is started by pressing the SWEEP/V OUTPUT key (12).

Figure 3-2. Front Panel Features (Sheet 6 of 12)



(19) FUNCTION Select Keys:

These keys select the measurement function and, when the Blue key (11) is on (key indicator lamp is lit), change the measurement mode from C mode (non-sweep) or C-V mode (bias sweep) to C-t mode (time sweep) and back again. When the instrument is in C mode or C-V mode, the indicator lamp on the selected function key lights continuously, and the functions labelled in black (C-G, C, and G) are valid. When the instrument is in C-t mode, the indicator lamp on the selected function key flashes off and on, and the functions labelled in grey (C•G-t, C-t, and G-t) are valid.

C-G, C, G:
When C-G is selected, the 4280A measures both capacitance, C, and equivalent parallel conductance, G. When C or G is selected, only capacitance or only conductance, respectively, is measured. The 4280A is in C mode when INTERNAL BIAS (13) is set to ⎓ or OFF; it is in C-V mode when INTERNAL BIAS is set to ⎍ or ⎎ .

C•G-t, C-t, G-t:
These functions are available only when the 4280A is in C-t mode (time sweep). To set the instrument to C-t mode, press the Blue key (11) (key indicator lamp should come on), and then press the desired FUNCTION key. The indicator lamp at the center of the key will begin to flash. The other two functions can now be selected directly, without the Blue key. To change back to C mode or C-V mode, press the Blue key again, and then press the function key whose indicator lamp is flashing.

Figure 3-2. Front Panel Features (Sheet 7 of 12)

(20) C-G RANGE Keys and Indicators:

These keys select the ranging mode--AUTO or MANUAL--and the measurement range. The three adjacent indicator lamps show the selected measurement range.

AUTO:
When the indicator lamp at the center of this key is on, the 4280A is in AUTO ranging mode and will automatically select the measurement range that best suits the value of the device under test.

MANUAL:
When this key is pressed, the AUTO key indicator lamp will go off and the measurement range will be fixed at the selected range. To change measurement range, press this key. To return to AUTO ranging mode, press the AUTO key.

(21) C-HIGH RESOLN Key (Option 001 Only):

This key enables high resolution capacitance measurements. It is used in conjunction with the CORRECTION ENABLE key (4) and the C-OFFSET keys (32). Refer to paragraph 3-161 for details.

(22) SELF TEST Key:

This key initiates the instrument's SELF TEST function. During SELF TEST (key indicator lamp is on), eight tests that check the basic operation of the instrument are automatically performed. Nothing must be connected to the UNKNOWN terminals (27) during the test. SELF TEST is repeated until this key is pressed again. If an abnormality is detected, an error code will be displayed on the C display (6). SELF TEST error codes are described in paragraph 3-7. When SELF TEST is canceled, the instrument is set to its initial control settings. If this key is pressed unintentionally, control settings can be maintained by quickly pressing this key again, while SELF is displayed on the C and G displays. Refer to paragraph 3-7 for complete details on SELF TEST.

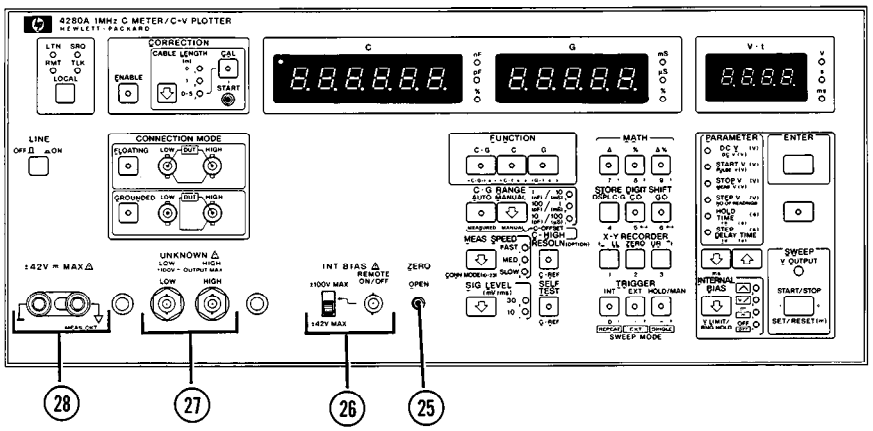
(23) SIG LEVEL Select Key and Indicators:

This key selects the test signal level--30mVrms or 10mVrms. The adjacent indicator lamps show the selected test signal level.

(24) MEAS SPEED Select Key and Indicators:

This key selects the measurement speed—FAST, MED, and SLOW. Actual measurement speed depends on the control settings and the value of the device under test. The adjacent indicator lamps show the selected measurement speed.

Figure 3-2. Front Panel Features (Sheet 8 of 12)



(25) ZERO OPEN Button:

This button is for ZERO offset compensation of the stray capacitance and conductance inherent in the test fixture, test leads, and measurement circuit. When this key is pressed, the test fixture or test leads must be terminated open (nothing connected).

(26) INT BIAS⚠:

This slide switch and BNC connector are safety features that, respectively, limit and shut down the output from the internal dc bias source.

REMOTE ON/OFF:

This connector is used for remote on/off control of the internal dc bias source when the adjacent slide switch is set to the ±100V MAX position. When the center conductor of this connector is grounded (mechanically or electrically), the internal dc bias source outputs the specified voltage. When the center conductor is left open or when a TTL level HIGH is applied to it, output from the internal dc bias source is shut down.

⚠CAUTION

DO NOT APPLY AN EXTERNAL DC BIAS VOLTAGE TO THIS CONNECTOR.

WARNING

DO NOT USE THE FURNISHED BNC SHORTING CAP FOR GROUNDING THE REMOTE ON/OFF CONNECTOR.

Limit Switch:

This switch limits the output voltage from the internal dc bias source. It also functions as a mechanical stop when set to the ±100V MAX position, preventing connection of test fixtures designed for low voltage measurements.

±100V MAX.:

Maximum output (±100V) from the internal dc bias source is possible. Connection of HP test fixtures designed for use at ±42V and below is made physically impossible. The center conductor of the REMOTE ON/OFF connector must be grounded to enable output from the internal dc bias source.

±42V MAX.:

Output from the internal dc bias source is limited to ±42 volts to ensure operator safety.

Figure 3-2. Front Panel Features (Sheet 9 of 12)

(27) UNKNOWN Terminals⚠:

These two BNC connectors are the 4280A's measurement terminals. They have a two-terminal pair configuration: HIGH terminal and LOW terminal. Two-terminal pair test fixtures, such as the furnished 16080A, connect directly to these terminals.

⚠WARNING

WHEN BIAS VOLTAGE IS USED DANGEROUS VOLTAGE (MAXIMUM ±100V) MAY APPEAR ON THESE TERMINALS.

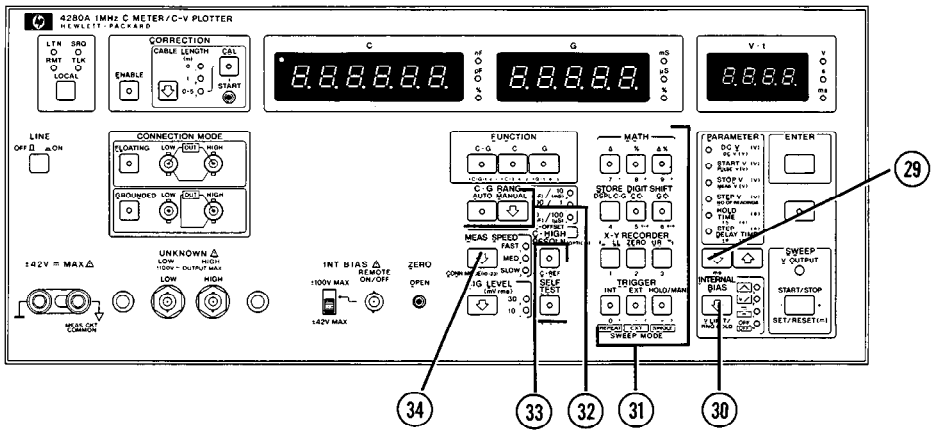
(28) Ground(⊥)-MEAS CKT COMMON (⏚) Terminals⚠:

The ground terminal (⊥) is tied directly to the instrument's chassis and to the earth terminal (offset pin) of the ∿ LINE input receptacle ((10) in Figure 3-3) on the rear panel. The MEAS CKT COMMON (⏚) terminal is tied directly to the common of the instrument's measurement circuit and to the outer shields of the UNKNOWN terminals (27). These terminals can be interconnected with the attached shorting strap.

⚠WARNING

THE GROUND-REFERENCED POTENTIAL ON THE EXPOSED OUTER SHIELDS OF THE UNKNOWN TERMINALS AND ON THE MEAS CKT COMMON TERMINAL (⏚) CAN BECOME DANGEROUSLY HIGH WHEN THE GROUND (⊥) AND MEAS CKT COMMON TERMINALS ARE NOT INTERCONNECTED.

Figure 3-2. Front Panel Features (Sheet 10 of 12)



Blue shift Functions

The following functions are labelled in blue on the front panel. They are available when the Blue key (11) is on (when the key indicator lamp is lit).

(29) ms (millisecond) Key:

This key is used when entering time parameters. Pressing this key after a time value has been keyed in with the numeric keys (31) changes the time unit from seconds to milliseconds. The ms unit indicator lamp on the V·t display (8) will light.

(30) V LIMIT/RNG HOLD Key:

This key is used to set the maximum allowable output from the internal dc bias source during non-sweep constant bias measurements (C mode). It also sets the range (and therefore the resolution) of the output voltage. To set the output voltage limit, press the Blue key, press the V LIMIT/RNG HOLD key (the previously set limit or Auto will appear on the V·t display (8)), key in the desired limit with the numeric keys (31), and then press ENTER (10). Refer to paragraph 3-62 for details.

(31) Numeric Keys:

These keys—0 through 9, decimal point and minus sign—are used for entering parameter values, MATH function reference values, and other numeric data. Press ENTER (10) to validate numeric data that has been keyed in.

(32) C-OFFSET Keys (Option 001 only):

These keys are used with the C-HIGH RESOLN key (21) to enter capacitance offset values. Refer to paragraph 3-161 for details.

MEASURED:

Pressing this key and then the ENTER key (10) when the C-HIGH RESOLN key (21) is on (key indicator lamp is lit) sets the measured capacitance value as the offset value.

MANUAL:

This key is used to manually set the capacitance offset value with the numeric key (31) and ENTER key (10).

Figure 3-2. Front Panel Features (Sheet 11 of 12)

(33) C-REF/G-REF Keys:

These keys are used to store reference values for the MATH functions (14) and to recall (display) previously stored reference values.

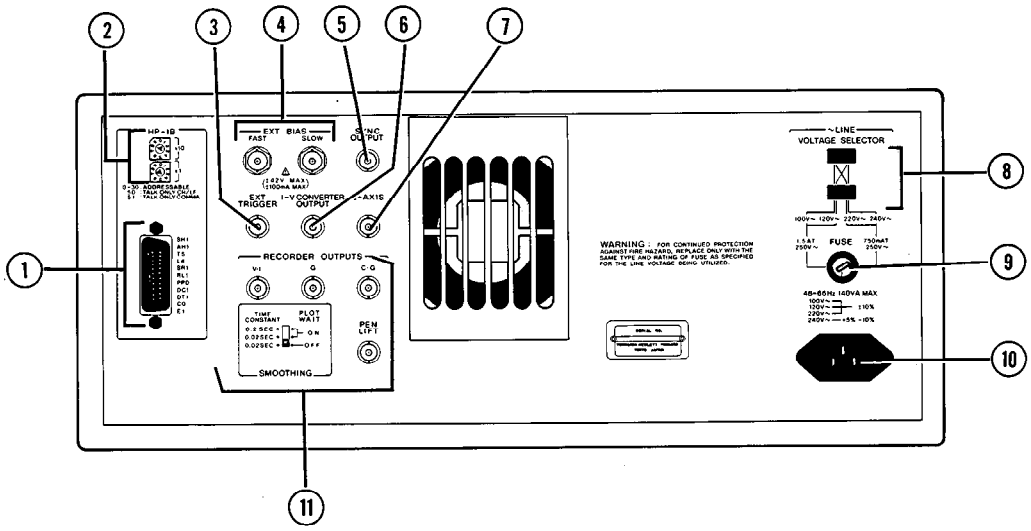
C-REF: Pressing this key while the Blue key (11) is on displays the stored reference values for capacitance and conductance on the C display (6) and G display (7), respectively. Also, r- E F is displayed on the V·t display (8). A capacitance reference value can be entered with the numeric keys (31) and the ENTER key (11).

G-REF: This key is for entering conductance reference values. It functions in the same manner as the C-REF key.

(34) CONN MODE Key:

This key is used to select the connection mode with the numeric keys (31) and ENTER key (11). Refer to paragraph 3-31 for details.

Figure 3-2. Front Panel Features (Sheet 12 of 12)



(1) HP-IB Connector:

Twenty-four pin connector. Connects the instrument to the Hewlett-Packard Interface Bus for remote operation.

(2) HP-IB Address Switches:

These rotary switches set the instrument's HP-IB address (0 to 30) for ADDRESSABLE operation, and the data delimiter (50: CR/LF, and 51: comma) for TALK ONLY operation. Refer to paragraph 3-164 for details.

(3) EXT TRIGGER Connector:

This BNC connector is for triggering the instrument with an external triggering device or a TTL level signal. TRIGGER/SWEEP MODE must be set to EXT. Details are given in paragraph 3-54.

(4) EXT BIAS Connectors⚠:

These BNC connectors—FAST and SLOW—are used in measurements that require an external bias source. Refer to paragraph 3-100 for details.

⚠CAUTION

DO NOT ALLOW DC BIAS CURRENT APPLIED TO EXT BIAS CONNECTORS TO EXCEED ±100mA. DOING SO MAY RESULT IN DAMAGE TO THE 4280A.

⚠WARNING

DO NOT ALLOW DC BIAS VOLTAGE APPLIED TO EXT BIAS CONNECTORS TO EXCEED ±42V OR DANGEROUS VOLTAGE MAY APPEAR AT THE MEASUREMENT TERMINALS.

(5) SYNC OUTPUT Connector:

This BNC connector is used for C-t mode measurements in which the bias pulse is supplied from an external dc bias source. A TTL level HIGH is output from this connector during the th period of the measurement. Refer to paragraph 3-126 for details.

Figure 3-3. Rear Panel Features (Sheet 1 of 2)

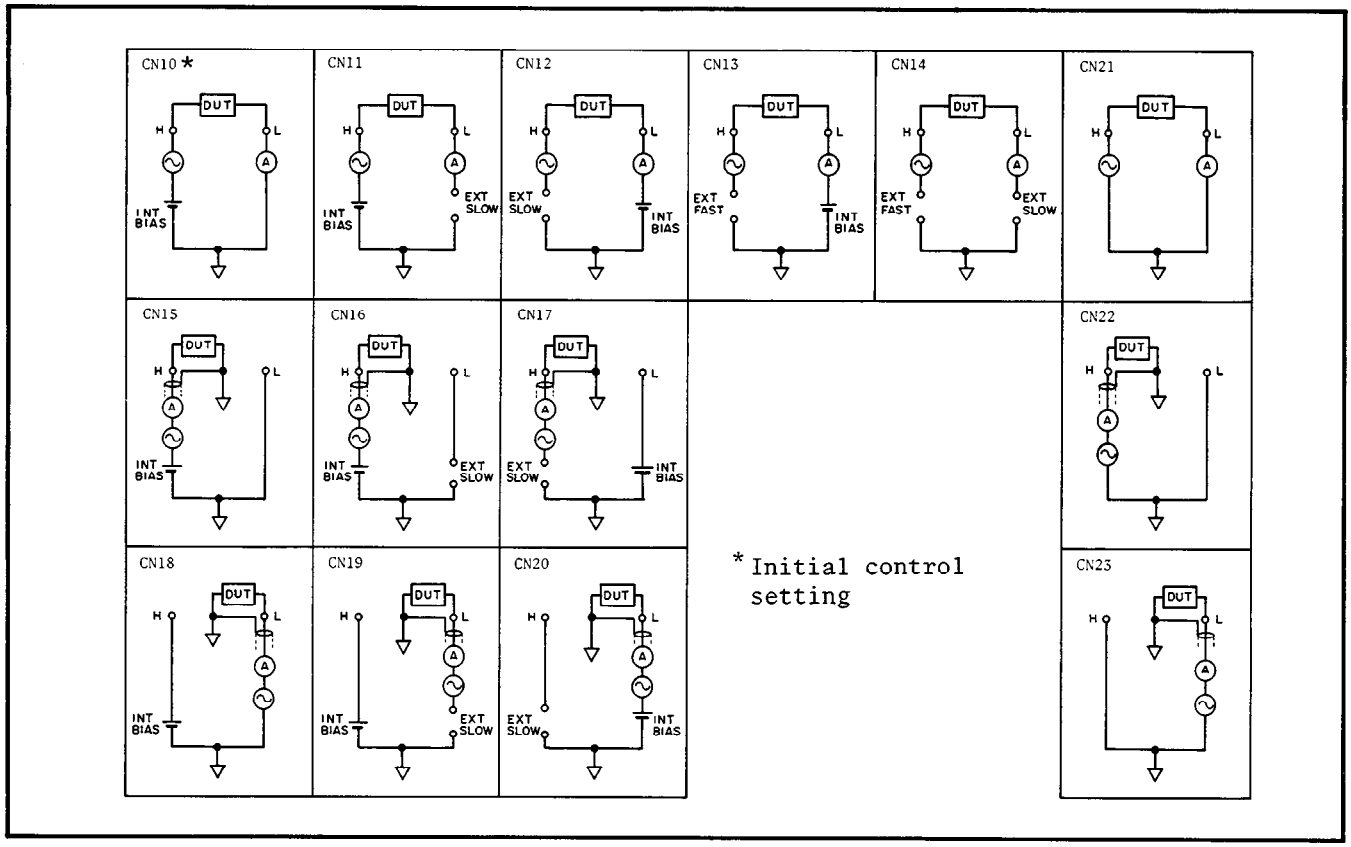


Figure 3-8. Connection Modes

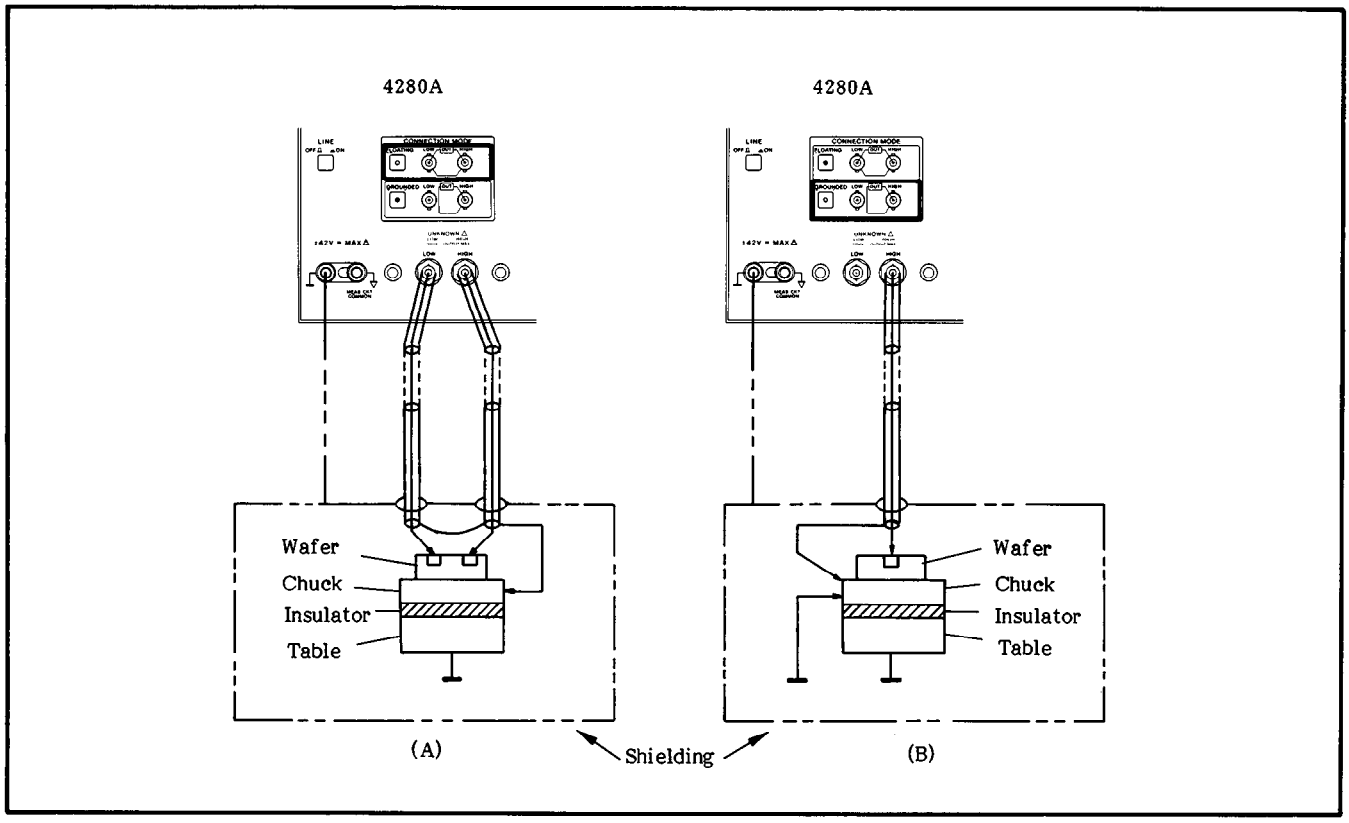


Figure 3-12. Connection Using a Wafer Prober

3-37. Figure 3-12 shows two methods of using a wafer prober to connect a test sample to the 4280A. If the chuck of the wafer prober is not grounded, as shown in (A), the test sample is considered floating. Conversely, if the chuck is grounded, as in (B), the test sample, which is in contact with the chuck, is considered grounded.

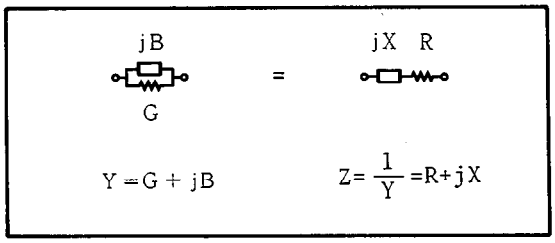
Note

If the impedance between the grounded terminal of the sample and ground is low, disconnect the shorting strap that interconnects the ground terminal (⊥) and the MEAS CKT COMMON terminal (⏚) on the front panel.

3-38. EQUIVALENT CIRCUITS

3-39. Any complex impedance can be represented by a simple series or parallel equivalent circuit consisting of a single resistive element and a single reactive element. This is possible because both equivalent circuits have identical impedances at a given test frequency if the equivalent circuit elements are properly established. The 4280A measures the capacitance, C, and conductance, G, of the equivalent parallel circuit of the device connected to the UNKNOWN terminals.

3-40. The capacitance value obtained from an equivalent parallel circuit measurement will differ from the value obtained from an equivalent series circuit measurement. The difference is due to the loss of the device being measured. The higher the loss, the larger the difference. The impedance of the device under test, whether measured as an equivalent parallel circuit or equivalent series circuit, is the same at any given frequency. This can be proven mathematically, as follows.



$$R + jX = \frac{1}{G + jB}$$

$$= \frac{G}{G^2 + B^2} - j\frac{B}{G^2 + B^2}$$

Expanding, we have

$$R - j\frac{1}{\omega C_S} = \frac{G}{G^2 + \omega^2 C_P^2} - j\frac{\omega C_P}{G^2 + \omega^2 C_P^2}$$

where Cp is the equivalent parallel circuit capacitance (B/ω) and Cs is the equivalent series circuit capacitance ($-1/\omega X$). Obviously, if the device under test has no losses--that is, if series resistance, R, and parallel conductance, G, are both zero--equivalent series capacitance, Cs, and equivalent parallel capacitance, Cp, will be equal. The correlation between Cs and Cp can be easily determined by using a simple conversion formula that considers the dissipation factor. Refer to Table 3-5. In short, capacitance values obtained from equivalent series circuit and equivalent parallel circuit measurements are nearly equal when the dissipation factor, D, of the device is less than 0.03. The dissipation factor of a component measured at a given frequency will be the same for both series and parallel equivalents.

Table 3-5. Dissipation Factor Equations and Equivalent Circuit Conversion Formulas

Equivalent Circuit	Dissipation Factor	Conversion to Other Modes
	$D = \frac{G}{\omega C_P} = \frac{1}{Q}$	$C_S = (1 + D^2)\, C_P$, $R = \frac{D^2}{1 + D^2} \cdot \frac{1}{G}$
	$D = \omega C_S R = \frac{1}{Q}$	$C_P = \frac{1}{1 + D^2} C_S$, $G = \frac{D^2}{1 + D^2} \cdot \frac{1}{R}$

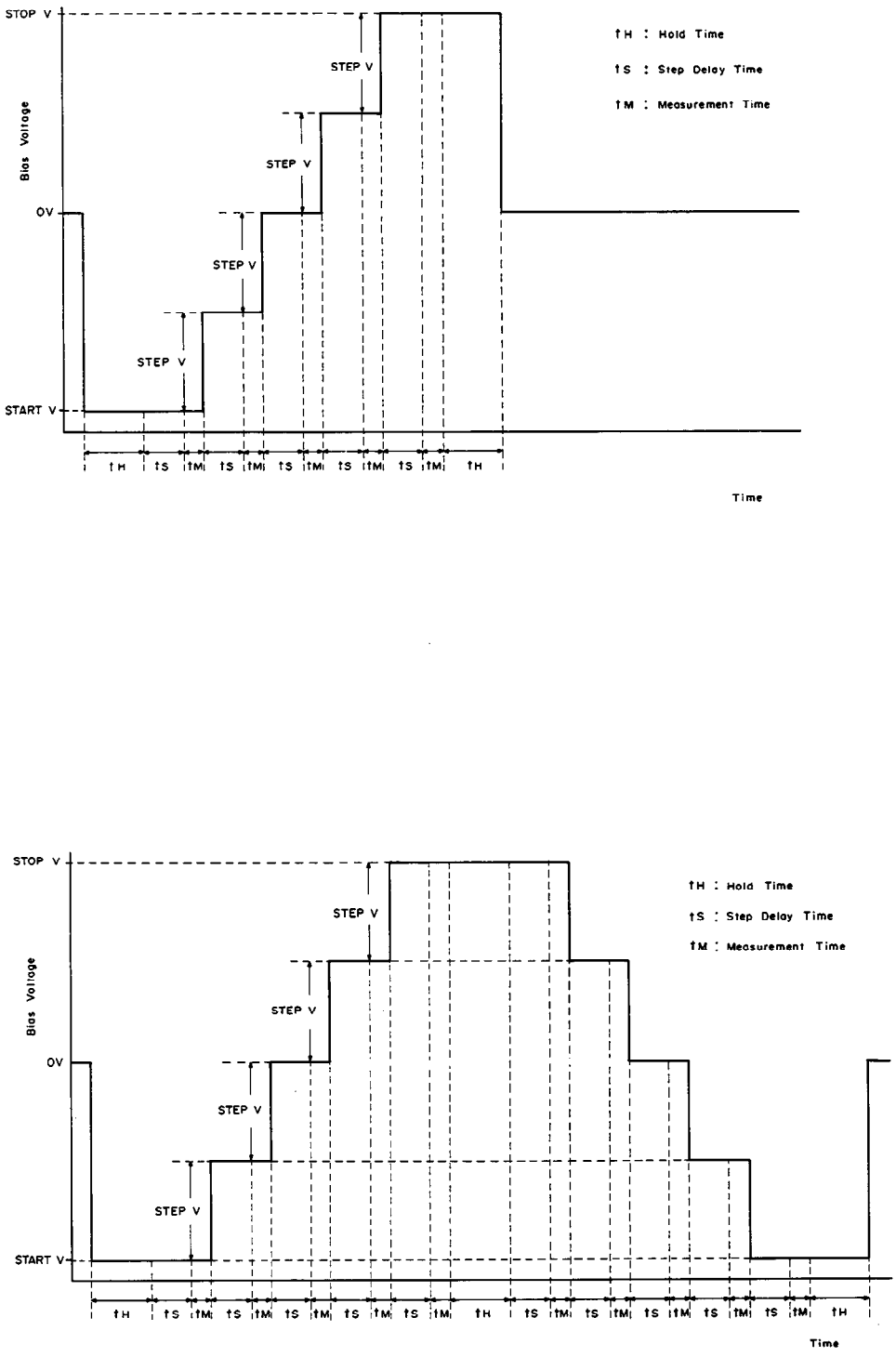


Figure 3-20. Bias Sweep Set-up Procedure (Sheet 1 of 3)